

Tropical Products Institute

G 151

Economic aspects of small-scale fish canning

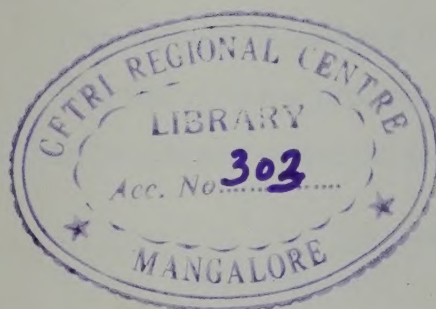


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Economic aspects of small-scale fish canning

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Overseas Development Administration

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Contents

	Page
SUMMARIES	
Summary	1
Resumé	3
Résumen	5
SECTION 1	SCOPE AND PURPOSE OF THE REPORT
Aims and objectives of the report	7
World production trends of canned fish products	7
Structure and content of the report	9
SECTION 2	GENERAL ASPECTS OF FISH CANNING
The pre-requisites for a fish cannery	10
The fish canning process	14
International codes of practice and standards	15
SECTION 3	STAGES IN THE CANNING OF SARDINES, TUNA AND SHRIMP
Sardines	17
Tuna	19
Shrimp	22
SECTION 4	DEVELOPMENT AND FINANCIAL ANALYSIS OF THE COST MODELS
Introduction	25
Design of the cost models	25
Costs	26
Revenue	27
Financial analysis	28
Relative performance of the cost models	29
Conclusions	30
APPENDICES	
1	Establishment and operating costs for Models 1, 2 and 3
2	List of items of capital equipment

LIST OF TABLES IN TEXT

1	Disposal of the world fish catch 1970–78	8
2	Dimensions of common can sizes	13
3	Cooking times for tuna by size	20
4	Cost models – summary of capital, annual operating costs and revenue	27
5	Results of the discounted cash flow analyses	29
6	The Internal Rates of Return resulting from the sensitivity analysis	29

LIST OF TABLES IN APPENDIX 1

1.1	Cost of raw materials and packing materials	33
1.2	Cost models – labour requirements	34
1.3	Cost models – annual consumption of electricity, fuel oil and water	34
1.4	Cost models – working capital	34
1.5	Cost models – revenue from sales of cans of sardines and of fish waste	35
1.6	Discounted cash flow, Model 1	35
1.7	Discounted cash flow, Model 2	35
1.8	Discounted cash flow, Model 3	36

LIST OF FIGURES IN TEXT

1	Flow chart of the canning of sardines	18
2	Flow chart of the canning of tuna	21
3	Flow chart of the canning of shrimp	23

Summaries

SUMMARY

Economic aspects of small-scale fish canning

- 1 The general approach of this report is to indicate to administrators, planners and potential investors the technical and economic factors it is essential to evaluate when considering the establishment and successful operation of a small fish canning enterprise in tropical countries.
- 2 The basis of the report is a series of physical and financial cost models. Factor costs pertinent to a particular developing country have been applied for purposes of analysis. However, the physical requirements are set out to enable users of the report to apply factor costs appropriate to their own locality.
- 3 The main technical factors involved in fish canning are discussed and the process of canning is described in general terms. Specific characteristics of the canning of three varieties of fish are discussed; these are sardines, tuna and shrimp.
- 4 The cost models are based on the canning of sardines, although the general principles of financial analysis used are applicable to the canning of any type of fish. Three basic cost models have been developed:

Model 1 produces 10,000 cans from an 8-hour shift with an annual input of 500 tonnes of raw fish equating to 250 shifts worked per year.

Model 2 is of similar design but produces 20,000 cans from an 8-hour shift with an annual input of 1,000 tonnes of raw fish equating to 250 shifts worked per year.

Model 3 is of the same scale as Model 1, i.e. 10,000 cans per 8-hour shift, but substitutes labour for machinery in the operations of beheading and gutting the fish and labelling the cans.

All of the models have been tested in terms of sensitivity to the number of shifts worked per year.

- 5 In all cases the production of cans of 125 g is assumed, comprising 90 g of fish and 35 g of oil. A vegetable oil such as sunflower seed oil is assumed to be the filler ingredient.

- 6 The main items in the annual operating costs by proportion are:

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
Fish	22.5%	23%	21.4%
Filler	13%	13.5%	12.5%
Cans	40%	40.5%	38%
Labour	10.5%	10%	15.3%

- 7 The discounted cash flow method has been used to analyse the cost models. A project life of 10 years has been assumed and the Net Present Values of the cost models have been calculated using a discount rate of 10%. In addition, the Internal

Rates of Return have been calculated under the most optimistic assumptions of 250 shifts worked per year and with raw fish purchase prices at £120 per tonne and the sale-price of canned sardines at £0.18 per can. Using these assumptions, the following Internal Rates of Return were obtained for the basic models:

Model 1	Model 2	Model 3
61.5%	69.5%	59%

It is evident that if raw material is available in sufficient volume and of appropriate quality to enable 250 shifts to be worked and a market exists for the canned product then the canning operation is potentially highly profitable.

8 By comparing Model 1 with Model 2 it is shown that there are economies of scale. At wage rates used in this report the more labour-intensive model (Model 3) gives a marginally less attractive financial performance than Model 1 which is of the same scale.

9 However, under more stringent assumptions than those adopted above, the cost models were tested for sensitivity to independent variations to: (i) a more marked seasonality in supply of a reduction in shifts worked, (ii) a reduction in sale-price of 50% for output channelled into the domestic rather than the export market and (iii) an increase of 25% in annual operating costs. The Internal Rates of Return occurring in these situations are shown below which are considerably reduced:

	Model 1	Model 2	Model 3
(i) Operation over 200 shifts a year 150 shifts a year	47.5% 33.5%	54.0% 38.5%	45.0% 31.5%
(ii) 50% of output sold at £0.18 per can and 50% of output sold at £0.11 per can	33.5%	39.0%	29.5%
(iii) An increase of 25% in annual operating costs	36.7%	42.6%	32%

10 In practice many sardine canneries operate over a highly contracted season of 3 months or less, as it is often difficult to can for more than 75–80 days in a year. The resulting output is highly seasonal and often of relatively low volume which makes disposal onto the export market difficult. In addition, due to the marked seasonality of the resource, canners have had major problems in persuading fishermen to invest in gear to land sardine in sufficient quantities and of appropriate quality to sustain their ventures.

11 The apparently attractive Internal Rates of Return shown above should therefore be viewed with caution. In practice, due to the seasonality of the resource and other factors, canners may have to operate under a combination of less favourable conditions including low end-product prices, relatively short working seasons and high raw material costs. With this in mind, the financial analysis was extended to illustrate the combined effect of reducing the shifts worked per year to 150 and the exportable proportion of the product to 50% with the result of lowering end-product prices. This is a situation under which many canners have to operate.

The result is to reduce significantly the Internal Rates of Return for what becomes a risky venture:

	Model 1	Model 2	Model 3
Internal Rates of Return	14.0%	17.5%	11.0%
Net Present Value at 10%	£56,395	£181,779	£12,422

12 If in addition operating costs are increased by 25% to reflect higher raw material costs and the difficulty and expense of obtaining cans and other inputs, all of the Internal Rates of Return are negative and the projects are clearly not viable.

13 The imposition of the operating constraints often incurred in practice clearly illustrate how the high Internal Rates of Return of the basic models operating under 'ideal' conditions are rapidly eroded and how great care is required in assessing raw material availability and market prospects before embarking on a canning venture.

RÉSUMÉ

Aspects économiques de la mise en conserve de poisson sur une petite échelle

1 L'approche générale de ce rapport est d'indiquer aux administrateurs, aux planificateurs et aux actionnaires en puissance les facteurs techniques et économiques qu'il est essentiel d'évaluer lorsqu'on envisage la création et le fonctionnement satisfaisant d'une petite entreprise de mise en conserve de poisson dans les pays tropicaux.

2 Le rapport a pour base une série de modèles de coût physiques et financiers. Des coûts de facteurs se rapportant à un pays en voie de développement particulier ont été appliqués pour les besoins de l'analyse. Cependant, les besoins physiques sont établis pour permettre aux utilisateurs du rapport d'appliquer les coûts des facteurs correspondant à leur propre localité.

3 Les principaux facteurs techniques intervenant dans la mise en conserve de poisson sont discutés et le processus de mise en conserve est décrit en termes généraux. Les caractéristiques spécifiques de la mise en conserve de trois sortes de poisson sont discutées; ce sont les sardines, le thon et les crevettes.

4 Les modèles de coût sont basés sur la mise en conserve des sardines, bien que les principes généraux de l'analyse financière utilisée sont applicables à la mise en conserve de n'importe quel type de poisson. Trois modèles de coût fondamentaux ont été mis au point:

Le modèle 1 produit 10.000 boîtes de conserve par poste de 8 heures avec un apport annuel de 500 tonnes de poisson cru équivalent à 250 postes travaillés par an.

Le modèle 2 est de conception analogue, mais il produit 20.000 boîtes de conserve par poste de 8 heures, avec un apport annuel de 1.000 tonnes de poisson cru équivalent à 250 postes travaillés par an.

Le modèle 3 est du même ordre d'importance que le modèle 1, c'est-à-dire 10.000 boîtes de conserve par poste de 8 heures, mais il substitue la main d'œuvre aux machines dans les opérations où les poissons sont étêtés et vidés et également d'étiquetage des boîtes.

Tous les modèles ont été testés en ce qui concerne la sensibilité au nombre des postes travaillés par an.

5 Dans tous les cas on admet la production de boîtes de 125 g comprenant 90 g de poisson et 35 g d'huile. Une huile végétale, telle que l'huile de tournesol, est supposée être l'ingrédient de charge.

6 Les principaux éléments dans les frais de fonctionnement annuels sont les suivants, en pour cent:

	Modèle 1	Modèle 2	Modèle 3
Poisson	22,5%	23%	21,4%
Charge	13%	13,5%	12,5%
Boîtes	40%	40,5%	38%
Main d'œuvre	10,5%	10%	15,3%

7 La méthode de débit au comptant avec remise a été utilisée pour analyser les modèles de coût. On a supposé une durée de vie du projet de 10 ans et les valeurs actuelles nettes des modèles de coût ont été calculées en utilisant un taux d'escompte de 10%. De plus, Les marges de bénéfice internes ont été calculées en formulant les hypothèses les plus optimistes de 250 postes travaillés par an et avec des prix d'achat du poisson de £120 par tonnes et le prix de vente des sardines en boîtes de £0,18 par boîte. En utilisant ces hypothèses les marges de bénéfices internes suivantes ont été obtenues pour les modèles de base:

Modèle 1	Modèle 2	Modèle 3
61,5%	69,5%	59%

Il est évident que si on dispose de matière première en quantité suffisante et de qualité appropriée pour assurer le travail de 250 postes et s'il existe un marché pour écouler le produit en boîtes, l'opération de mise en conserve est potentiellement hautement bénéficiaire.

3 En comparant le Modèle 1 et le modèle 2, on montre qu'une économie est obtenue. Avec les marges de salaire utilisées dans ce rapport, le modèle avec le plus de main d'oeuvre (Modèle 3) donne à la limite une performance financière moins attrayante que le Modèle 1 qui est du même ordre d'importance.

9 Cependant, en formulant des hypothèses plus rigoureuses que celles adoptées plus haut, les modèles de coût ont été testés en ce qui concerne la sensibilité vis-à-vis des variations indépendantes vers: (i) un caractère saisonnier plus marqué de l'approvisionnement en cas d'une réduction des postes travaillés, (ii) une réduction du prix de vente de 50% pour la production acheminée sur le marché interne plutôt que sur le marché d'exportation, et (iii) une augmentation de 25% des frais de fonctionnement annuels. Les marges de bénéfice internes obtenues dans ces conditions sont présentées ci-dessous; elles sont considérablement réduites:

	Modèle 1	Modèle 2	Modèle 3
(i) Fonctionnement de plus de 200 postes par an	47,5%	54,0%	45,0%
150 postes par an	33,5%	38,5%	31,5%
(ii) 50% de la production vendue à £0,18 par boîte et 50% de la production vendue à £0,11 par boîte	33,5%	39,0%	29,5%
(iii) Augmentation de 25% des frais de fonctionnement annuels	36,7%	42,6%	32%

10 En pratique, beaucoup de conserveries de sardines fonctionnent au cours d'une saison fortement restreinte de 3 mois ou moins étant donné qu'il est souvent difficile de mettre en boîtes pendant plus de 75 à 80 jours par an. La production qui en résulte est hautement saisonnière et souvent d'un volume relativement faible, ce qui rend difficile l'écoulement sur le marché de l'exportation. De plus, compte tenu du caractère très saisonnier des ressources, les dirigeants des conserveries ont eu de grosses difficultés à persuader les pêcheurs à investir en engins de pêche pour débarquer des sardines en quantités suffisantes et de qualité appropriée pour faire marcher leurs entreprises.

11 Les marges de bénéfice internes apparemment attrayantes qui sont présentées plus haut doivent par conséquent être considérées avec prudence. En pratique, eu égard au caractère saisonnier des ressources et à d'autres facteurs, les dirigeants des conserveries peuvent avoir à fonctionner en présence d'une combinaison de conditions moins favorables comprenant des prix bas du produit final, des saisons de travail relativement courtes et des prix élevés de la matière première. Compte tenu de ces faits, l'analyse financière a été étendue pour illustrer l'effet combiné de la réduction des postes travaillés par an à 150 et de la proportion exportable du produit à 50% avec pour conséquence un abaissement des prix du produit final. C'est une situation dans laquelle beaucoup de conserveries doivent fonctionner.

La conséquence est qu'on doit réduire significativement les marges de bénéfice internes et l'entreprise devient risquée:

	Modèle 1	Modèle 2	Modèle 3
Marges de bénéfice internes	14,0%	17,5%	11,0%
NPV à 10%	£56.395	£181.779	£12.422

12 Si de plus les frais de fonctionnement sont augmentés de 25% pour refléter les prix plus élevés de la matière première et les difficultés et les dépenses liées à obtention des boîtes et d'autres éléments, l'ensemble des Marges de bénéfice internes sont négatives et il est évident que les projets ne sont pas viables.

13 Les contraintes de fonctionnement imposées, souvent subies en pratique, illustrent clairement comment les marges de bénéfice internes élevées des modèles de base fonctionnant dans des conditions 'idéales' s'amenuisent rapidement et avec quel soin il faut évaluer la disponibilité des matières premières et les perspectives des marchés avant de s'embarquer dans une aventure de mise en conserve.

RESUMEN

Aspectos económicos del enlatado de pescado a pequeña escala

- 1 El enfoque general de este informe es para indicar a los administradores, planificadores, y posibles inversores los factores técnicos y económicos que será indispensable evaluar cuando se considera el establecimiento y la explotación próspera de una empresa pequeña de conservas de pescado en los países tropicales.
- 2 La base del informe la constituye una serie de modelos de costo físico y financiero. Los costos de factores pertinentes a un país particular en vías de desarrollo han sido aplicados a los efectos de análisis. No obstante, los requerimientos físicos han sido dispuestos de modo que permitan a los usuarios del informe aplicar los costos de aquellos factores apropiados a su propia localidad.
- 3 Se tratan los principales factores técnicos relativos al enlatado de pescado y se describen en términos generales las fases del proceso. Se estudian las características específicas del enlatado de tres variedades de pescado, a saber: la sardina, el atún y el camarón.
- 4 Los modelos de costo están basados en la conserva de sardinas, si bien los principios generales del análisis financiero usado son aplicables al enlatado de cualquier tipo de pescado. Se han desarrollado tres modelos de costo básicos:

El modelo No 1 produce 10.000 latas con un relevo de 8 horas y una entrada anual de 500 toneladas de pescado crudo, lo cual equivale a 250 relevos trabajados al año.

El modelo No 2 es de diseño parecido pero produce 20.000 latas con un relevo de 8 horas y una entrada anual de 1.000 toneladas de pescado crudo, equivalente a 250 relevos trabajados al año.

El modelo No 3 es de la misma escala que el modelo No 1, es decir: produce 10.000 por relevo de 8 horas, pero sustituye la mano de obra por maquinaria en las operaciones de descabezado y destripado del pescado y del etiquetaje de las latas.

Todos los modelos han sido comprobados en lo que respecta a la sensibilidad con arreglo al número de relevos trabajados por año.

- 5 En todos los casos se presupone la producción de latas de 125 g compuesta por 90 g de pescado y 35 g de aceite. Se da por descontado que el ingrediente de relleno sea un aceite vegetal como por ejemplo el de semilla de girasol.

- 6 Las partidas principales de los costos de operación anuales por proporción son:

	<i>Modelo 1</i>	<i>Modelo 2</i>	<i>Modelo 3</i>
Pescado	22,5%	23%	21,4%
Relleno	13%	13,5%	12,5%
Latas	40%	40,5%	38%
Mano de obra	10,5%	10%	15,3%

- 7 Se ha usado el método de flujo de caja descontado en el análisis de los modelos de costo. Se ha supuesto una duración de proyecto de 10 años y los valores presentes netos de los modelos de costo han sido calculados usando un tipo de descuento del 10%. Además los porcentajes de reembolso interiores han sido calculado a base de el supuesto más optimístico de 250 relevos trabajados por año y con precios de compra de pescado a 120 libras esterlinas por tonelada y el precio de venta de las sardinas enlatadas a 0,18 libras esterlinas por lata. Usando estas suposiciones, se obtuvieron los porcentajes de reembolso interiores para los modelos básicos:

<i>Modelo 1</i>	<i>Modelo 2</i>	<i>Modelo 3</i>
61,5%	69,5%	59%

Es evidente que si la materia prima puede obtenerse en suficientes cantidades y es de la calidad apropiada para permitir 250 relevos trabajados, y siempre que exista una demanda del producto en conserva, la operación del enlatado será con toda probabilidad sumamente remunerable.

8 Mediante la comparación del Modelo 1 con el Modelo 2 se demuestra que economías de escala se pueden obtener. Con los porcentajes de sueldos pagados en el presente informe el modelo más intensivo en mano de obra (Modelo 3) ofrece un rendimiento financiero marginalmente menos atractivo que el Modelo 1 el cual es de la misma escala.

9 No obstante, bajo suposiciones más estrictas que las adoptadas anteriormente, se comprobaron los modelos de costo en lo que respecta a su sensibilidad a variaciones de tipo independiente como: (i) un elemento estacional más marcado en el suministro de una reducción de relevos trabajados, (ii) una reducción en el precio de venta de un 50% para la producción encauzada hacia el mercado doméstico en lugar de hacia el mercado de exportación y (iii) un aumento de un 25% en los costos de operación anuales. Los porcentajes de reembolso interior en estas situaciones se muestran a continuación, y se comprobará que están considerablemente reducidos:

	Modelo 1	Modelo 2	Modelo 3
(i) Operación a lo largo de 200 relevos al año	47,5%	54,0%	45,0%
150 relevos al año	33,5%	38,5%	31,5%
(ii) 50% de producción vendida a 0,18 libras esterlinas y 50% de producción vendida a 0,11 libras esterlinas por lata.	33,5%	39,0%	29,5%
(iii) Un aumento de un 25% en los costos de operación anuales.	36,7%	42,6%	32%

10 En la práctica, numerosas factorías de conservas operan a base de una temporada intensamente contratada de 3 meses o menos de duración, ya que resulta a menudo difícil llevar a cabo la operación de enlatado durante más de 75–80 días en el año. La producción resultante es sumamente estacional y con frecuencia de volumen relativamente bajo, lo cual hace que su salida al mercado de exportación sea difícil. Además, debido a la marcada característica estacional de la fuente del producto, las empresas de conservas han tenido problemas importantes tratando de persuadir a los pescadores a que inviertan en la compra de equipos para capturar la sardina en cantidades suficientes y de la calidad apropiada para mantener su remunerabilidad.

11 Los aparentemente atractivos porcentajes interiores de reembolso mostrados anteriormente deberán así pues considerarse con precaución, ya que en la práctica debido al carácter estacional de la fuente del producto y a otros factores, las empresas de conservas puede que tengan que operar en una combinación de condiciones menos favorables incluyendo precios bajos para el producto final, temporadas de trabajo relativamente cortas y costos elevados de materias primas. Teniendo esto en cuenta, se amplió el análisis financiero con el fin de ilustrar el efecto combinado de reducir el número de relevos trabajados al año hasta 150, y la proporción exportable del producto en un 50% con el resultado de bajar los precios del producto final. Esta es una situación en la cual han de operar muchas empresas de conservas.

Esto resulta en una reducción bastante marcada de los porcentajes de reembolso interiores y como consecuencia se convierte en una empresa arriesgada:

	Modelo 1	Modelo 2	Modelo 3
Porcentajes de reembolso interior	14,0%	17,5%	11,0%
NPV al 10%	£56.395	£181.779	£12.422

12 Si además de esto se aumentan todos los gastos de operación en un 25% para reflejar costos de materia prima más elevados, unido a la dificultad y los gastos de obtener las latas y otros materiales, todos los porcentajes de reembolso interiores serán negativos y los proyectos resultarán evidentemente impracticables.

13 La imposición de limitaciones de operación incurridas frecuentemente en la práctica, ilustra de manera clara cómo los porcentajes de reembolso interior de los modelos básicos que funcionan en condiciones 'ideales' se merman rápidamente, así como el cuidado extremado que ha de ponerse en la evaluación de la disponibilidad de materias primas y de las perspectivas del mercado antes de lanzarse a la empresa de la conserva de pescado.

Scope and purpose of the report

1.1 AIMS AND OBJECTIVES OF THE REPORT

This report is one of two prepared by the Tropical Products Institute on the economics of selected aspects of fish processing. This report examines the economics of fish canning while the other report, (Street, P. R., Clucas, I. J., Jones, A. and Cole, R. C. (1980) Economic aspects of small-scale fish freezing. *Report of the Tropical Products Institute, G146*, iv + 47 pp.) studies the economic factors involved in fish freezing. These studies on fish processing have been undertaken because of the increasing interest being shown by many countries in developing and utilising their fish resources in order to provide more dietary protein from local sources or to earn foreign exchange from the export of certain products. The expansion of a fishing industry usually necessitates the development of processing facilities, owing to the perishable nature of the product. The method of processing chosen in any situation will clearly depend on local circumstances, but may reflect a desire to even out the supply of fish onto a market by freezing, or to supply inland markets with fish in a form which is safe to eat even when the required shelf life is relatively long, i.e. in a canned form. Alternatively Governments may seek the opportunity of earning foreign exchange through the export of high-value canned or frozen products.

Canning and freezing are only two of the available means of preserving fish. Among other methods which are common in many developing countries are chilling, salting, drying and smoking. These methods have not been considered however, partly because they are well known, but in particular because the cost of individual operations depends very much on the conditions in any one locality. Fish meal and fish silage manufacture for animal feed are further activities which utilize fish and fish waste products through preservation. These activities may be directly linked to or be located near other fish processing operations, such as canning.

The objective of this report is to indicate to administrators, planners and potential investors in developing countries the technical and economic factors it is essential to evaluate when considering the establishment of a fish canning venture. Particular attention is paid to small-scale canning plants and the effect of undertaking certain operations by hand rather than by machine. The report indicates the way the comparative cost of manual and automated processing methods may be assessed.

1.2 WORLD PRODUCTION TRENDS OF CANNED FISH PRODUCTS

In the years 1975–78 the canning of fish represented an average of 13.3% of the total utilisation of the world fish catch, or 18.8% of that which was used for human consumption. Up to the early 1970s the forms of fish consumption which showed the fastest rate of growth in their utilisation of the world's fish catch were fish canning and fish freezing. Since then, and as is shown in Table 1, consumption of canned fish has grown at a similar rate to the total human consumption of fish. Consumption of frozen fish has grown somewhat faster.

Japan, the USA, South Africa and certain European countries are the main producers of canned fish products. Among developing countries Mexico, Morocco,

Table 1

Disposal of the world fish catch 1970–78

	1970	1975	1976	1977	1978
Total world catch					
Live weight (million metric tonnes)	68.14	68.60	72.11	71.21	72.38
Index (1969–71 = 100)	104	105	110	108	110
Disposal indices (1969–71 = 100)					
Human consumption					
of which:	102	116	120	124	124
Marketed fresh	102	121	120	135	128
Frozen	101	120	135	130	133
Cured	104	102	104	99	104
Canned	102	116	118	119	122
Other uses	106	85	91	82	87

Source: *FAO Yearbook of Fishery Statistics 1978*, Volume 47, FAO, Rome

Brazil and Peru have been the most significant producers. For most developing countries only a small proportion, if any, of their fish catch is canned; the bulk of their catch is sold either in fresh or cured form.

In developing countries a fish cannery could be expected to:

- (i) assist in the development of a region through the setting up of an agro-industry which can increase the amount of value added to raw material;
- (ii) operate under a fairly wide range of factor prices since there is a high rate of substitution between labour and machinery in many of the operations in a canning line, thus there is the possibility of providing a large number of employment opportunities; and
- (iii) provide opportunities for the development of local entrepreneurial experience since fairly small size units can be viable.

The advantages of canning over other forms of processing include the length of life of the fish preserved in the can (normally at least 2 years), and the relatively low transport and storage costs associated with the distribution of the product.

However, the absence of fish canning operations in many developing countries may reflect some of the difficulties in establishing and operating canneries. Several fish canneries have been established over the years in developing countries which are seriously under-utilized or have failed to succeed because of inadequate assessment of the pre-requisites of the establishment of a fish cannery discussed in 2.1 (see p. 10). Moreover, as will be evident in Section 4, a significant element of operating costs is that of the cans themselves. These can be expensive items for a developing country, particularly if it lacks can-making plant and is dependent on imported supplies. Particular problems in establishing fish canning enterprises in many countries involve:

- (i) the fact that there are few places where a regular supply of suitable raw material can be caught at low cost. Where this is so, freezing often offers a more profitable alternative;
- (ii) a high level of technical expertise is required to produce high quality products;
- (iii) the fact that there are difficulties in establishing export markets for what are often low volumes of product; and
- (iv) the short season for many fish species makes it difficult to persuade fishermen to invest in harvesting equipment and can result in high fixed costs per unit of fish landed.

1.3 STRUCTURE AND CONTENT OF THE REPORT

The main technical factors involved in canning fish are discussed in Section 2 and those specific to three particular canned products, i.e. sardines, tuna and shrimp are reviewed in Section 3. Materials for these are found in most tropical areas. It is not possible to describe the canning procedure for all species of fish and shellfish. However, as indicated later in the report, the basic canning process is similar for all varieties of fish, only the details of individual operations alter, reflecting either the characteristics of the raw material or the form in which consumers prefer the final product. The report should therefore be of general relevance to those considering the establishment of a fish canning operation. Although the main technical factors are summarised, the Tropical Products Institute can be approached for assistance in any aspect of fish canning operations not dealt with in this study.

An appraisal of some of the economic aspects of fish canning is presented in Section 4. The approach adopted is to outline the development of physical cost models giving the inputs of equipment, building space, labour, services and materials required for small-scale canning plants. This includes an assessment of the comparative cost effect of hand and automated methods for certain of the operations. To illustrate the workings of these models, specific factor costs relevant to developing countries have been applied and the financial performance of the models examined. This methodology can be used with local cost/price data for any locality to provide a preliminary estimate of capital and annual operating costs to evaluate potential profitability and the case for undertaking a full feasibility study. The construction of these models has been based on the requirements for canning sardines only. The general principles however are applicable to the canning of any fish.

General aspects of fish canning

2.1 THE PRE-REQUISITES FOR A FISH CANNERY

Most authorities are agreed that a number of factors must exist before a fish cannery can be established. Their existence does not of course imply the success of a fish canning operation, but it can safely be said that their absence will seriously undermine the viability of a canning project. The principal factors are listed below:

- (i) the existence of a market;
- (ii) the availability of a suitable species of fish in sufficient regular quantities which can be caught, landed in prime condition over a sufficiently long season to provide sufficient raw material to permit profitable operation;
- (iii) a suitable site for the cannery;
- (iv) availability of suitable labour and management staff;
- (v) adequate transport facilities for raw materials and finished product;
- (vi) a water supply of suitable quality and quantity;
- ✓ (vii) a reliable supply of cans;
- (viii) availability of vegetable oil and additives;
- (ix) adequate power supplies; and
- (x) technological expertise.

2.1.1 The existence of a market

The first requirement is that there should be a market which can absorb the quantity of canned fish it is intended to produce at a certain price and level of quality. It is therefore necessary to identify either a domestic market for canned fish or an export market(s). Since products such as canned tuna and shrimp are high value products, it is sensible to consider exporting most of the production. Even if there is a shortage of protein in the country of manufacture, it is unlikely to be practical to sell the product to the local population. Such a policy would entail a cost to society in terms of the subsidy required to enable local consumers to purchase an expensive product and in the foreign exchange earnings foregone. Assuming these products are exported, they will generate foreign exchange which could be used to import other food items if necessary. However it may be possible to market domestically cans consisting of lower-value packs, for instance in the case of tuna, the flake pack.

Where export markets are being considered for canned fish products, it is important to take particular note of the incidence and level of trade barriers, especially if the product is likely to compete with a similar product produced domestically in that market. This could apply, for example, in the case of sales of canned tuna from a developing country to the USA. Several developed countries which are potential markets for exports in canned fish products impose tariffs on imports of these products primarily to protect their own fish processing industries. At the same time,

however, imports of frozen fish of the same species are often imported at either zero or minimal rates of duty. In certain cases, therefore, it may be more economic to consider exporting the fish in a frozen rather than canned form, especially if the demand for a canned product is not strong.

As far as sardines and other low valued products are concerned, it may well make economic sense to sell them on the local market where they can improve both the amount and variety of local diets at prices which the market can bear. If canned sardines are already imported into such a market, it is most unlikely that a locally produced brand will take a sizeable share of the market in the first instance, owing to consumer preference for other brands. The total market therefore needs to be well in excess of the minimum output of a cannery to enable it to absorb most if not all of the cannery's output. Production which cannot be absorbed by the local market might be exportable to neighbouring countries, although it will invariably be in competition with well established brands of the same product.

It is also important to remember that in many tropical countries domestic demand for canned fish may be constrained by low income levels. For lower-income consumers, traditionally preserved low-cost fish products such as salted/dried and smoked may well be major competitive factors limiting demand for canned fish.

Having identified a potential market, the second step is to estimate its size and its particular requirements in terms of price and quality. The main factors determining the demand for a canned fish product are as follows:

- (i) The price of the product in relation to close substitutes. This is probably the most important factor since most consumers of this type of product are extremely price conscious. It should also be borne in mind that the product will be competing with many other similar products, including canned meats.
- (ii) The size of the population, its location and rate of growth. If there is a large concentration of people inland, and it is too expensive or impractical to transport fish in a chilled or frozen form, there may well be a market for a canned fish product. This again may, however, face competition from traditional salted/dried or smoked fish products.
- (iii) The level and rate of growth of *per capita* incomes. There is little doubt that there is a positive correlation between consumption of canned foods and rising incomes, partly reflecting a desire for convenience foods.
- (iv) In markets where there are several brands of the product on sale, demand will be influenced by brand loyalty. Consumer loyalty is most effectively gained by ensuring that the market receives regular supplies of a product of uniform quality. In almost all cases it is advisable first to carry out investigations to determine the quality of competing packs, and consumer preferences regarding such aspects as the appearance of the pack, the texture of the fish and the type of flavour preferred. Knowledge of consumer preferences with respect to filler ingredients (oil, tomato sauce etc.) will also assist in producing a product likely to gain consumer acceptability. Eventually some form of trial marketing might be desirable before a full-scale attempt to enter a given market is mounted.

2.1.2 The availability of a suitable species of fish

The availability of a suitable species of fish is clearly as important as the existence of a market. It is normal for fatty species of fish to be canned since they yield a better product than non-fatty species. It is advantageous if the size and oil content of the fish are reasonably uniform, since continual variations in the composition of the pack will do little to gain consumer loyalty to the product. However, with oil packs the final oil content can be adjusted to allow for variations in the oil content of the fish.

It is also evident that a small size cannery cannot function economically unless it has regular supplies of fresh fish. Substantial fluctuations in the supply will result in high

unit costs of production and may also result in the incurring of cold storage costs in an attempt to even out the supply. In the case of sardines and shrimp it would not in fact be economic to freeze prior to canning, chiefly because they could be sold in a dried or frozen form at less cost. Although attempts are being made to freeze and cold store sardines prior to canning to extend the season, it is by no means certain that it can be done satisfactorily and, if so, that it can be done profitably. Since tuna are usually caught at some distance from the canning plant and may need to be frozen while at sea, it may be essential to install cold storage facilities in the tuna cannery as one freezer vessel could land more fish than can be put through a small cannery in a day, while several freezer vessels might land their catch in the same day.

It can therefore be concluded that canneries should not be established until there are substantial quantities of fish available, which, in the case of sardines, can be landed at the cannery in a few hours, thus enabling the plant to process the material in as fresh a state as possible. If there is any doubt as to the amount of fish available, its quality or the suitability of the species for canning, a careful check should be made.

2.1.3 A suitable site for the cannery

It is important that the site be near a fishing harbour, chiefly to avoid the problems that will occur if fish have to be transported some distance after being landed. Usually this is not a difficulty and sites can be found near a harbour. The cannery will also require supplies of labour, electricity, substantial quantities of potable water, and facilities for the disposal of effluent.

A considerable proportion of the landed fish will become a waste product during the process of canning. This loss arises from beheading and gutting and from fish considered not suitable. With sardines, for instance, as much as 50% of the live weight could be waste.

Disposal of this waste product therefore has to be considered. In view of its potential value as a raw material for production of fish meal, it is preferable to make arrangements for sale to a fish meal plant where possible. Such an arrangement provides additional revenue to the cannery and avoids the costs and potential pollutant effect of alternative means of disposal. Alternatively some of the raw material unsuitable for canning could be used to produce food for human consumption which would be preferable to the production of fish meal.

In considering the site for a cannery therefore, disposal of waste should be taken into account. A cannery may be sited adjacent to an existing fish meal plant, though these plants may well be established in the vicinity of a cluster of canneries associated with the activities of a fishing harbour.

In the case of canneries with relatively small throughputs, limited quantities of waste product would be available, and in some developing countries disposal of this limited quantity of waste product through a fish meal plant may not be a practical proposition. Consideration could then be given to the production of fish silage adjacent to the cannery as an alternative means of disposal.

2.1.4 Availability of suitable labour and management staff

It is possible to operate a canning line with large amounts of labour or alternatively with a high degree of automation. In situations where foreign exchange and capital is scarce and expensive, a cannery can be economically viable if there is a supply of unskilled and semi-skilled labour near the cannery. It should be noted that the annual operations of a cannery may be limited by the seasonality of supplies of fish. Much of the labour can often be hired on a seasonal basis, but items of fixed capital equipment cannot. It should also be mentioned that many canned food industries are competitive and profit margins are often small. It is therefore imperative to recruit experienced production and management staff, and if local expertise is not available there is a case for hiring expatriate management until local managers can be trained to manage the plant.

2.1.5 Cans

The availability and cost of cans is an important factor influencing the viability of fish canning projects and is one which often presents problems in developing countries. The absence of the production of good quality cans in many developing countries necessitates recourse to expensive imports of cans or of tinplate from which cans can be stamped out. The import of tinplate for the local manufacture of cans is only a practicable proposition if the scale of the canning industry is fairly large. The cost of cans becomes a very significant item in total operating costs while the need to hold adequate stocks of cans to ensure regular supply adds to working capital requirements.

Can sizes are identified by a statement of their dimensions (over-all diameter and over-all height), each dimension being expressed as three digits. The first digit represents the number of whole inches and the next two digits represent any additional fraction expressed as sixteenths of an inch. The diameter of the can is given by the first number and the height of the can by the second number. Thus the can size 301 x 106 represents a can $3\frac{1}{16}$ inches in diameter and $1\frac{6}{16}$ inches in height. However with rectangular cans used for products such as sardines three numbers are used. These represent length, width and depth (e.g. 405 x 301 x 014).

Table 2 sets out the dimensions of the common can sizes used in the canning industry and their approximate metric equivalents (1 inch equal to 25.4 millimetres).

Table 2

Dimensions of common can sizes

Dimensions 'inches'	Dimensions 'millimetres'
<i>Diameter x height</i>	<i>Diameter x height</i>
202 x 204	54.0 x 57.2
202 x 214	54.0 x 73.0
211 x 109	68.3 x 39.7
211 x 212	68.3 x 69.9
211 x 304	68.3 x 82.6
211 x 400	68.3 x 101.6
300 x 109	76.2 x 39.7
300 x 400	76.2 x 101.6
300 x 407	76.2 x 112.7
301 x 106	77.8 x 34.9
301 x 408	77.8 x 114.3
303 x 406	81.0 x 111.1
303 x 509	81.0 x 141.3
307 x 113	87.3 x 46.0
307 x 200.25	87.3 x 51.2
307 x 306	87.3 x 85.7
307 x 400	87.3 x 101.6
307 x 409	87.3 x 115.9
307 x 510	87.3 x 142.9
307 x 512	87.3 x 146.1
401 x 411	103.2 x 119.1
404 x 307	108.0 x 87.3
404 x 700	108.0 x 177.8
603 x 405	157.2 x 109.5
603 x 408	157.2 x 114.3

2.1.6 Quality control

In addition to the points given above, attention needs to be given to quality control. Since a fish cannery deals with a highly perishable raw material, it is essential that the canned product is rendered safe and bacteriologically stable by the use of heat, but that this heat process is limited so as to change the flavour and texture as little as possible. Considerable attention should therefore be paid to factors such as the handling of fish, time/temperature relationships and maintenance of machinery to ensure that quality standards are met, and that regular laboratory tests are made on samples of raw materials and the finished product.

2.2 THE FISH CANNING PROCESS

2.2.1 Introduction

Canning is a means of preserving fish (and certain other foods) by heat processing in hermetically sealed containers at temperatures which are high enough to halt the activity of the bacteria and enzymes present in the fish. In practice complete sterility is not always attained, since some micro-organisms may survive the process. Canneries *must* process sufficiently to destroy all spores of *Clostridium botulinum* which is the most heat-resistant pathogenic organism (the so-called 'botulism cook'). Canneries will usually use a more severe process than this in order to destroy bacteria which could cause spoilage. This process renders the product 'commercially sterile'.

There are certain types of bacteria capable of forming spores which are resistant to heat, and the processing times and temperatures used are normally the minimum required to eliminate most of these. One of the chief problems is to find the optimum time/temperature relation for the fish involved since there is only a small margin between the temperature required to sterilize the pack and that which might impair the quality of the final product. Processes which are insufficiently severe will result in spoilage of the fish. Processes which are too severe may result in undue shrinkage of the fish, the possibility of scorching and particles of fish adhering to the sides of the can and may impair the texture and flavour of the fish.

2.2.2 Stages in the canning of fish

The following discussion is concerned only with canning procedures in the course of which the can is heated so that the fish flesh is cooked and the bones softened. The product can be eaten straight from the can.

(i) Handling fish prior to canning

Only raw material of the highest possible quality should be canned. Spent fish, that is those that have just spawned and thus have lean and watery flesh, should not be used. If spoiled fish are canned the product will have poor flavour and texture. Fish must be either chilled or frozen immediately they are caught so that they reach the cannery in prime condition, unless they can be landed in less than 5 hours from the time they are caught. Chilled fish may be buffer stored at 0°C for a short period, or frozen and then cold stored; frozen fish may be cold stored. Storage time should be as short as practicable both to maintain product quality and to reduce the expense of storage. The length of time for which fish can be stored depends upon the species of fish and the storage temperature; it would be unwise to generalise on this point.

(ii) Fish preparation

The preparation needed depends on the species of fish used, the type of product to be made, and the state in which the fish arrive at the cannery. Preparation may include heading, gutting, scaling, fin removal, cutting into steaks or, as with tuna, pre-cooking.

(iii) Washing

Raw fish should be carefully washed to remove blood, slime, loose scales etc.

(iv) Filling the can

In small factories the cans are always filled by hand. In large factories the process may be mechanised to some degree and special machines are made for packing tuna. The cans are filled to a pre-determined weight and check-weighed. A head space of 3–5 mm must be left at the top to ensure that a partial vacuum is created and to allow for expansion of the contents during heat processing. In most cases raw fish are put in the can; in some cases the fish are cooked first.

(v) Addition of other ingredients

Salt is almost always added; sometimes this is done by brining the raw fish, or by the addition of a small pellet of salt, or salt crystals.

Some packs are made in vegetable oil, such as olive oil, cottonseed oil or sunflower seed oil; others are made in tomato sauce, curry sauce, mustard sauce, etc.

Monosodium glutamate is sometimes added in minute quantities as a flavour enhancer.

Cans may be check-weighed after the addition of ingredients other than fish, but it is normally the weight of fish that is of specific importance.

(vi) Exhausting and sealing of the can

Air must be removed from the can so as to avoid oxidation of the contents and to permit the formation of a partial vacuum. Exhausting may be carried out by: hot filling; by heating the can and its contents before sealing; by displacing the head space air with steam before sealing; or by using a partial vacuum produced by mechanical means. In the costings given later in this report it has been assumed that the vacuum seaming method is employed.

The lids are put on the cans and the edges folded over or seamed by a special machine known as a 'seamer'. It is important that the seam is correctly formed or otherwise the can may leak, bacteria may enter and spoil the contents or render them extremely toxic.

(vii) Heat processing

This is of critical importance. The cans are placed in a retort (a very large pressure cooker) and cooked under a standard pressure for a standard period of time which depends on both can size and the type of product. The process is adjusted to ensure that the contents at the centre of the can are held at a specified temperature for a sufficient period of time to kill the spores of *Clostridium botulinum*. As already noted, it is important not to over-cook or flavour and texture may be damaged or destroyed. It is thus necessary to cool the cans rapidly; this is usually done by flooding the retort with cold water under pressure. The water must contain free chlorine to ensure that it does not have any live bacteria in it because it is possible for the cooling water to enter the cans at this stage. Cans should be dried as soon as possible after processing.

(viii) Labelling and packing

Cans are labelled and packed into cardboard cases, usually 48 cans to a case.

(ix) Storage

Cases are stored in a dry room.

(x) Quality control

A small factory does not need an expensive quality control laboratory but simple facilities should be provided. Sample cans must be drawn from each day's production and stored at 37°C for 14 days to check that they were properly sealed and have been adequately processed.

2.3 INTERNATIONAL CODES OF PRACTICE AND STANDARDS

The Codex Alimentarius Commission of the Joint FAO/WHO Food Standards Programme has published a series of international codes of practice and standards among which fish and fish products are covered. Prospective producers of canned fish are advised to consult these documents for guidance as to recommended practices and procedures. The following are examples of publications in this series relevant to the fish canning industry:

- (i) Recommended International Code of Practice for Canned Fish. (*Codex Alimentarius Commission, CAC/RCP 10–1976; Joint FAO/WHO Food Standards Programme*).
- (ii) Recommended International Standard for Canned Tuna and Bonito in Water or Oil, (*Codex Alimentarius Commission, CAC/RS 70–1974; Joint FAO/WHO Food Standards Programme*).
- (iii) Recommended International Standard for Canned Shrimps or Prawns. (*Codex Alimentarius Commission, CAC/RS 37–1970, Rev 1; Joint FAO/WHO Food Standards Programme*).

Where exports to markets in North America, Western Europe and other developed countries are being considered standards for labelling and quality are likely to exist. For instance, according to USA regulations, labels on all imported food products must give the following information:

- Name of product
- Country of origin
- Name of producer or distributor
- Ingredients, in descending order of importance
- Net content weight, in both ounces, and pounds and ounces (if applicable)
- All information in English; if any foreign terms are used, all terms must show both English and foreign equivalent

Advice on labelling and inspection requirements in the following developed country markets may be obtained at the addresses given below

USA

US Food and Drug Administration
Associate Director for Compliance
Division of Regulatory Guidance
200 C Street, NW
Washington DC 20204
USA

Japan

The Japan Canned Foods Inspection Association
3–11 Kyobashi
Chuo-Ku, Tokyo 104
Japan

UK

Ministry of Agriculture, Fisheries and Food
Food Standards Division
Great Westminster House
Horseferry Road
London SW1P 2AG
UK

Stages in the canning of sardines, tuna and shrimp

3.1 SARDINES

3.1.1 General considerations

The main steps in the canning of sardines are shown in Figure 1. It is important to note that sardines are canned in a number of ways, reflecting tradition or consumer taste, and that there is no single method. As may be seen from Figure 1 there is a choice between cooking in the can or cooking the fish prior to canning, and, if the latter method is adopted, the fish may be cooked in oil, in steam or in hot air. Cooking in the can is a common method today and its advantage over cooking prior to filling reflects the relative ease of handling fish in a raw rather than a cooked state. This method (cooking in the can) is described below and will be used as a basis for the costings in Section 4.

3.1.2 Species of fish

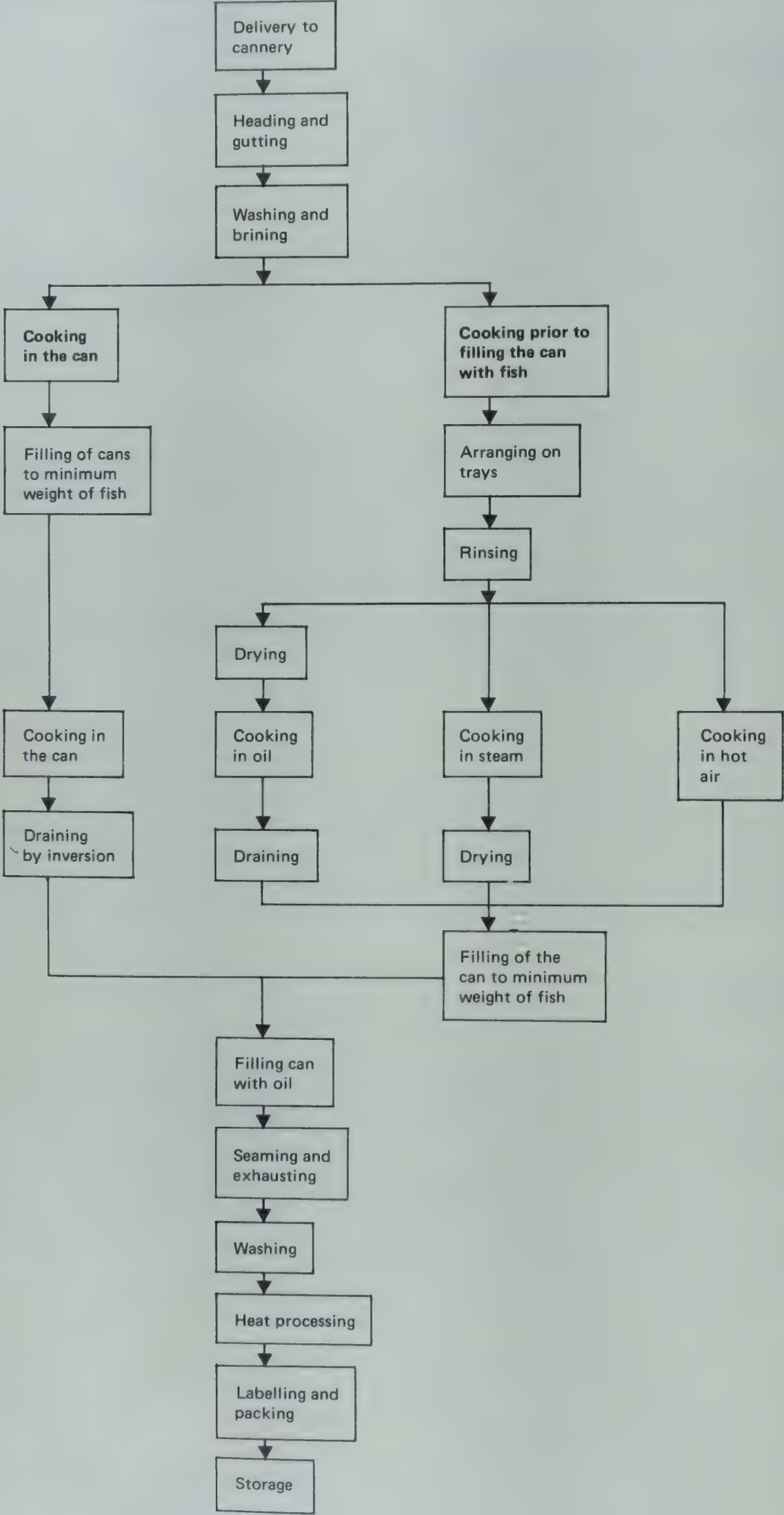
In some countries only *Clupea pilchardus*, the true sardine, may be labelled as 'Sardine' after processing. Other fish, of the genus *Sardinella* and allied genera, make a somewhat inferior but not necessarily unsatisfactory pack. Since fish of different species may require different processing it is necessary to know what fish species are available and whether more than one is likely to be landed in any particular catch.

3.1.3 Canning sardines

The main points in the canning of sardines are as follows:

- (i) Sardines are small, delicate, oily fish. It is thus advisable to process them as soon as possible after they are caught and landed. While it is technically possible to freeze and cold store such fish, storage times are short and the process is not generally profitable, nor does it yield a first-class product.
- (ii) The preparation of the fish is normally undertaken by hand. When processing the true sardine the scales are not removed since these are soft and unobjectionable and provide protection for the soft skin. For other types of sardine it may be necessary to remove the scales and sometimes also the fins. At this point in the process, waste and offal is collected which could be used in the manufacture of fish meal or fish silage.
- (iii) The fish are immersed in a brine tank for a few minutes. The aim is to ensure a salt content of about 2% in the finished product; brine strength and brining times are varied to achieve this end with fish of different sizes and varying fat contents.
- (iv) In Section 4 it is assumed that the cannery uses rectangular cans holding 125 g of fish and oil. The cans are filled with fish, by hand, so that the processed can contains approximately 90 g of fish. In filling to a minimum weight (which has to be shown on the label) allowance is made for cooking losses.

Figure 1
Flow chart of the canning of sardines



- (v) The cans are steam-cooked and then inverted to drain off exuded water. Lean sardines require a longer cooking time than fat sardines.
- (vi) Approximately 25 g of oil or tomato sauce is added to the pack. In small canneries this might be done manually, more usually a dispenser is used.
- (vii) The cans are then sealed by an automatic vacuum sealer with a capacity of up to 50 cans per minute.
- (viii) Processing times at 240° F (115–116° C) vary from 30 minutes for a small can to 180 minutes for a large can.
- (ix) The cans would then be wrapped in heavy paper, usually an oiled paper, packed in cartons and stored.

It has been assumed for the purposes of this report that the weight of fish in the processed pack represents some 45% of the weight accepted for canning. (In general, some 33% of the accepted fish is lost in heading and gutting and a further 26% of the weight of the fish is lost as exuded water after cooking). In practice, one of the major problems in attempting to establish a sardine cannery is that the quality of the fish landed by fishermen is often such that a very high percentage of the catch must be rejected as unsuitable and unacceptable for canning. Rejected fish can, of course, be sold on the market for fresh consumption or other purposes but such usages are less profitable than canning.

3.2 TUNA

3.2.1 General considerations

A tuna canning proposal should always be given very careful consideration before a decision to proceed is taken. While canned tuna is in demand in many countries, tuna canning often requires a large investment in both boats and refrigeration equipment, while good management is crucial if a new cannery is to survive in a very competitive market. Cold storage facilities are likely to be required, even in a small cannery. Any enterprise considering a tuna cannery should consider sales of frozen fish as an alternative to canning.

3.2.2 Species of fish

Canned tuna is produced from a number of species within the mackerel family. The main species of this group from the point of view of canning are:

Albacore (*Germo alalunga*)
 Yellowfin (*Thunnus albacares*)
 Bluefin (*Thunnus thynnus*)
 Skipjack (*Katsuonus pelamis*)

Under USA labelling laws only albacore may be labelled as 'white meat', the remainder are generally labelled as light meats. The bonitos (*Sarda* and allied genera) may not be labelled as tuna.

3.2.3 Canning tuna

The steps in the canning of tuna are indicated in Figure 2 and main points are as follows:

- (i) Since tuna are usually caught some distance from the shore it is necessary for the fish to be frozen at sea, which in turn necessitates thawing on arrival at the cannery. For small canneries cold storage facilities would be necessary as one freezer vessel could land more fish than can be put through a small cannery in one day, while several freezer vessels might land their catch on the same day.

- (ii) Once the fish have thawed out, the viscera are removed by hand and the fish is then inspected by sight, touch and smell to determine its suitability for canning. In the case of Japanese longliners, the practice is to gut and gill the tuna before freezing.
- (iii) Pre-cooking of the fish is carried out in steam at a maximum of 102° C. The main requirements are that the fish within any one batch are of the same temperature (i.e. fully thawed out) and are all of the same size, since cooking times increase with the weight of the fish (see Table 3). Following cooking, the fish should be allowed to cool for between 12–24 hours to allow the flesh to firm up.

Table 3

Cooking times for tuna by size

Weight of fish (kg)	Cooking time (hours)
2	1.25
4	1.5
6	2
10	2.25
12	2.5
17	2.75
24	4.5
35	5.5
45	6.5

Note: These cooking times are given for guidance only. Appropriate advice should be sought prior to the start-up of production

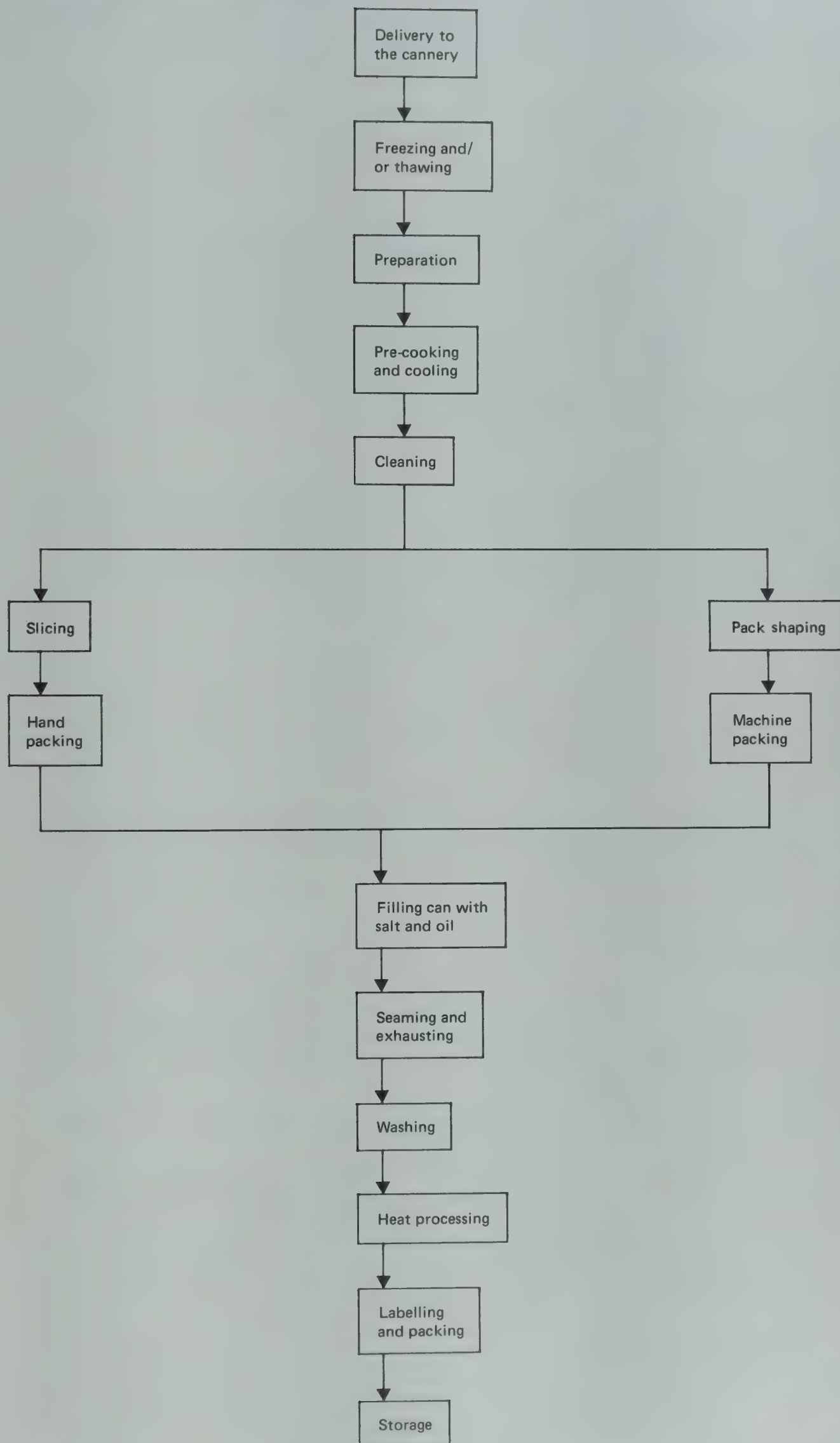
Source: LASSEN, S. (1965) Tuna canning and the preservation of the raw material through brine refrigeration. In: *Fish as Food Vol. IV* (ed. G. Borgstrom), pp. 207–245, New York and London: Academic Press, 518 pp.

- (iv) The fish are then cleaned, which comprises the removal of the head, fins, skin and backbone and the dark red meat lying along the lateral line. This operation is undertaken by hand and is the most labour consuming of all the operations in the canning line. It is especially important that no skin appears in the can.
- (v) The tuna are then ready for packing into the can. The way in which tuna are packed depends partly on whether it is cheaper to pack by hand or by machine, and partly on the type of pack it is intended to produce. Manual packing was the traditional way, but in the USA and Japan has largely been replaced by mechanical means. In the USA and Europe, three packs are normally sold:
 - a solid pack, consisting of large size chunks of tuna;
 - a chunk pack, as above with some small pieces; and
 - a flake pack, consisting entirely of small pieces, usually resulting from the filling of solid or chunk packs.

For the production of solid and chunk tuna by hand, the fish are first cut into the correct lengths by a guillotine. Production of flake tuna usually requires a machine to press the pieces into the can. Where tuna is packed entirely by machine, the pieces are first moulded into the correct shape, cut and then compressed into the can. It is essential that weights be checked on filling.

- (vi) Some brine is then added to the cans and possibly a small amount of oil. Salt is sometimes added dry rather than as brine; oil is added only if the pack is 'in oil' which is the largest market for canned tuna.
- (vii) Following washing and seaming the cans are processed.

Figure 2
Flow chart of the canning of tuna



It can be assumed that 2.5 kg of fresh tuna are required for the production of every 1 kg of canned tuna on the assumption that between 10–15% of the weight of the catch is lost from evisceration; 30% of the remainder is lost during the pre-cooking and a further 30% is lost from the removal of the dark meat, head and backbone.

3.3 SHRIMP

3.3.1 General considerations

The main consideration in the canning of shrimp is whether to produce a ‘wet pack’, where the shrimp are canned in brine, or a ‘dry pack’, packed without brine. The process is very similar for both, although longer cooking and drying times are required for the dry pack. There is also a choice between using labour or machines for certain operations, including peeling, grading and deveining where this is necessary. The fundamental choice however is whether to can shrimp or to freeze them. If there is any doubt over the regularity of supply, it may be more economic to sell frozen shrimp than to can a thawed product.

3.3.2 Species of shrimp

Many species of Penaeid shrimp (which include *Penaeus* and *Metapenaeus*, which are most likely to be used for canning) are suitable for canning; the main criterion as to whether shrimp are sold in a fresh, frozen or canned form is size. In the USA, the main market for the canned product, shrimp are graded according to the number of headless shrimp which weigh 1 lb (count) as follows:

Size	Number per lb (count)
Extra jumbo	less than 15
Jumbo	15–20
Large	21–25
Large medium	26–30
Medium	31–42
Small	43–65
Very small	more than 65

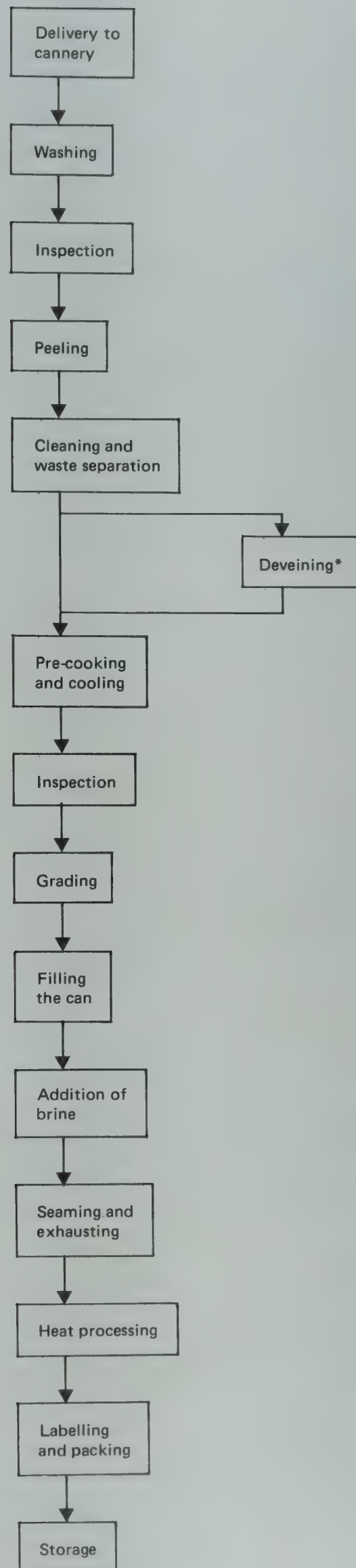
It is usual to can only those shrimp in the medium to very small size range, larger shrimp are sold in either a fresh or frozen form. In practice, often only the smallest shrimp are canned in quantity.

3.3.3 Canning shrimp

The steps in the canning of shrimp are outlined in Figure 3 and the main points are described below:

- (i) Since shrimp spoil rapidly at temperatures prevailing in the tropics, they should be chilled immediately after being caught and delivered to the cannery as soon as possible. This is the main problem in the tropics and the most difficult to solve.
- (ii) The raw material is washed, separated from the ice and then inspected to remove all discoloured and broken shrimp.
- (iii) The removal of the head and shells (peeling) may be undertaken either by hand or by machine; machines are available which are capable of handling between 230–400 kg of whole shrimp per hour. If the former method is used, it is essential to work quickly to avoid spoilage.
- (iv) A waste separator removes loose material and particles from the meat.
- (v) The shrimp are then pre-cooked (blanched) for between 6–10 minutes in a tank of boiling brine of 11–13% concentration. The importance of this stage is that the pre-cooking results in the curling of shrimp, produces the characteristic red or pink colour and exudes moisture from the shrimp. Small and medium size shrimp are generally cooked immediately after cleaning, but if larger shrimp are canned they must first be deveined (evisceration).

Figure 3
Flow chart of the canning of shrimp



* Only necessary for large shrimps

- (vi) The meat is inspected and graded. Grading is on the basis of size and may be undertaken by either machine or by hand.
- (vii) The cans are then filled with shrimp, by hand, before passing to a dispenser which adds brine of 7–8% concentration to each can to give the correct fill. Shrimp are likely to suffer from blackening and other discolouration in the can. Specially lacquered cans are available for use with shellfish and only these should be used for canning shrimp. Certain additives may also be used to lessen discolouration problems; also parchment or other liners are sometimes used for this purpose.
- (viii) After sealing, the cans are processed. A large proportion of the weight of the whole raw shrimp is lost during the canning process. A 198 g can of shrimp (307 x 113 can size) will contain approximately 127 g of peeled cooked shrimp which are equivalent to 454 g of whole, raw shrimp. Some 46% of the total weight is lost during peeling, while a further 45% of the weight of the peeled shrimp is lost during cooking. The yield of peeled, cooked meat is therefore about 28% of the total weight of whole, raw shrimp.

Development and financial analysis of the cost models

4.1 INTRODUCTION

In this section two basic cost models have been developed to illustrate the capital and operational costs of small fish canneries. A simple method of financial analysis is applied to show how this report can be used to carry out costings. By applying the data on physical cost requirements given in Appendix 1 (Tables 1.1 to 1.4), in conjunction with local factor costs, some indication of the basic economics of a cannery in different local situations can be obtained.

The cost models have been developed to consider and illustrate the canning of sardines only, although the general principles of analysis are applicable to the canning of any type of fish.

4.2 DESIGN OF THE COST MODELS

The two basic cost models differ in the scale of output, Model 1 being at the rate of 10,000 cans per 8-hour shift and Model 2 being at the rate of 20,000 cans per 8-hour shift. In addition, Model 3 has been developed to illustrate the effect of substituting labour for machinery in performing some of the operations in the canning process. This model is related to the lower scale of output of 10,000 cans a shift.

In all cases the basic cost models are based on 250 8-hour shifts per year, reflecting 250 days operation at 1 shift per day, 125 days at 2 shifts per day or any combination between these two limits. However, to show the effect of more marked seasonality of raw material supplies which pertain in many areas, operation of fewer shifts per annum to a lower limit of 150 is investigated. The latter reflects 150 days operation at 1 shift per day, 75 days operation at 2 shifts per day or any combination between these limits. The key variable costs are discussed and the effect of changes in them shown.

In designing the cost models it has been assumed that the cannery is located close to the fish landing site and that fish are purchased either on the open market or under contractual arrangements. No chilling facility or ice-making plant has been allowed for, it being assumed that fish are processed as landed. Fish waste is assumed to be sold for processing at a fish meal plant. It has been assumed that the species of fish caught and handled does not require scaling. This would not be true for some species which would be suitable for canning. The above assumptions are adopted for illustrative purposes only, to show the basic operations of the canning process. It is realised that in an actual situation these may not pertain in the manner ascribed. In particular, great care and attention is required in estimating the seasonal availability of the resource and because of this the willingness of fishermen to invest in sufficient gear to ensure adequate raw material supplies.

Serious consideration should also be given to the provision of ice-making plant and chill store facilities and/or freezing and cold store facilities, when the nature of the fish catching operations (scale, regularity, etc.) with which any cannery is associated is determined and the species of fish to be canned warrants such attention.

For some species of fish, such as tuna, a cannery may be part of a wider enterprise engaged in fish catching as well as processing and marketing. This arrangement will affect the nature and financial analysis of the cannery operations although such institutional complications have been set aside in this report which is concerned only to illustrate a generalized situation.

4.3 COSTS

The cost of capital equipment has been taken at f.o.b. UK prices for imported machinery and equipment, and estimates made for items likely to be of local manufacture and construction. Additionally, an allowance has been made of 15% in the case of equipment of foreign manufacture to cover insurance and freight costs. Where appropriate, an allowance of 15% has been made to cover installation and erection costs. An allowance has also been made for an initial stock of spare parts. A list of items of capital equipment is given at Appendix 2.

Annual operating costs have been set at levels likely to be found in developing countries.

Although for purposes of the costing it has been assumed that land is purchased, in many situations land would be available for lease by payment of an annual rent.

The capital and operating costs of the models which are used in the financial analysis below are summarised in Table 4. These costs have been derived from the physical requirements and financial values detailed in Appendix 1, Tables 1.1 to 1.4.

For Model 1, total fixed capital costs are some £125,000 and working capital some £178,000, making a total capital requirement of about £303,000. Annual operating costs total £266,900 of which some £26,000 represents fixed costs (including permanent staff). The most significant items of operating costs are fish (22.5%), filler (13%), cans (40%) and personnel (10.5%).

For Model 2, which represents a plant of similar design and equipment but with twice the capacity of Model 1, total fixed capital costs are some £215,000 and working capital some £353,000, making a total capital requirement of about £568,000. Annual operating costs total £522,750, of which some £43,000 represents fixed costs (including permanent staff). The most significant items of operating costs are fish (23%), filler (13.5%), cans (40.5%) and personnel (10%). Thus the cost structure is similar to that of Model 1.

For Model 3, which represents a plant of the same capacity as Model 1 but with a more labour-intensive design, total fixed capital costs are some £111,000 and working capital some £181,000, making a total capital requirement of about £292,000. Annual operating costs total £281,380, of which some £28,000 represents fixed costs (including permanent staff). The most significant items of operating costs are fish (21.4%), filler (12.5%), cans (38%) and personnel (15.3%). Personnel costs are a more significant item of operating costs than for Model 1 as the beheading and gutting machine and the labelling machine included in Model 1 have been replaced by labour. Correspondingly the fixed capital cost is lower than in Model 1.

The most notable aspect of the overall structure of operating costs for all three models is the high proportion (some 40%) represented by the cost of cans. For developing countries, canning often represents a high-cost method of preservation and packaging because of the need to import cans or the metal plate or sheet from which cans are pressed. This is particularly the case where the product to be canned is of relatively low value.

Table 4

Cost models – summary of capital, annual operating costs and revenue

Item	Model 1 (£)	Model 2 (£)	Model 3 (£)	Notes
Capital costs				
1 Plant and equipment	82,770	141,470	70,320	Cost of equipment listed at Appendix 2, including an allowance for freight, insurance and spares
2 Building costs	30,000	52,500	30,000	At £75/m ² : 400m ² for Models, 1, 3; 700 m ² for Model 2
3 Land	1,000	1,750	1,000	At £2,500 per ha: 0.4 ha for Models, 1, 3; 0.7 ha for Model 2
4 Contingencies	11,380	19,570	10,130	10% of rows 1 – 3
5 <i>Total fixed cost</i>	125,150	215,290	111,450	Sum of rows 1 – 4
6 Working capital	177,780	353,340	180,680	See Appendix 1, Table 1.4
7 TOTAL INVESTMENT	302,930	568,630	292,130	Sum of rows 5 and 6
Operating costs				
8 Fish	60,000	120,000	60,000	See Appendix 1, Table 1.1
9 Filler	35,000	70,000	35,000	See Appendix 1, Table 1.1
10 Cans	106,050	212,100	106,050	See Appendix 1, Table 1.1
11 Cartons	8,250	16,500	8,250	See Appendix 1, Table 1.1
12 Salt	200	400	200	See Appendix 1, Table 1.1
13 Personnel	27,900	52,050	433,340	See Appendix 1, Table 1.2
14 Water and sewage	580	1,160	580	See Appendix 1, Table 1.3
15 Electricity	830	1,080	620	See Appendix 1, Table 1.3
16 Fuel oil	6,800	13,600	6,800	See Appendix 1, Table 1.3
17 Maintenance and spares	5,240	9,050	4,620	5% of rows 1 and 2
18 Insurance	1,050	1,810	920	1% of rows 1 and 2
19 Quality control	5,000	8,000	5,000	Estimated
20 Sundries and unforeseens	10,000	17,000	10,000	Estimate of office expenses, protective clothing etc.
21 TOTAL OPERATING COSTS	266,900	522,750	281,380	Sum of rows 8 – 20
Revenue				
22 Cans of sardines	450,000	900,000	450,000	See Appendix 1, Table 1.5
23 Fish waste	2,475	4,950	2,475	See Appendix 1, Table 1.5
24 TOTAL REVENUE	452,475	904,950	452,475	Sum of rows 22 and 23

It was indicated in 4.2 (see p. 26) that consideration should be given to the need for ice-making plant and chill storage. For a cannery the size of Models 1 and 3, a 3-tonnes per day (24 hours) flake ice-plant might well be suitable. With a 6-tonnes capacity ice store this item would cost some £30,000 to £35,000, delivered and installed. Similarly, a 10-tonnes capacity chill store would cost up to £10,000 delivered and installed. The addition of these two items would thus increase capital costs in Models 1 and 2 by 30% to 40%.

4.4 REVENUE

In order to carry out the financial analysis it is necessary to determine the receipts which could be earned by the operation of the canneries represented by the cost models. These receipts comprise:

- (i) sales of cans of sardines; and
- (ii) sales of fish waste.

The unit values of these have been determined from experience in a particular developing country.

The sale price of cans of sardines is determined partly by the filler used; these are most commonly tomato sauce or vegetable oils such as sunflower seed oil and soya-bean oil or the more expensive olive oil. The sale price adopted in this report is related to the use of the cheaper vegetable oils, such as sunflower seed oil and soya-

bean oil, as a filler. In general, cans containing olive oil would be a higher value product while cans containing tomato sauce would be a lower value product.

For some species of fish the quality of fish and the manner in which it is packed may also affect sale price. This applies particularly to tuna where mention has been made in 3.2.3 (*see* p. 20) of the difference between solid and flake packs.

In the particular country from which the sale price of cans of sardines has been determined, there is a substantial difference between the prices received for export sales and for domestic market sales. The latter is considerably lower although over 75% of output is actually exported. In the financial analysis below, the export price has been used, but the effect of selling 50% of output on the domestic market, at a lower price, is also investigated.

In all cases the sale price for cans of sardine relate to a can of 125 g containing 90 g of fish and 35 g of oil.

It is assumed that fish waste is sold to a fish meal plant and comprises 33% by weight of the fish input into the cannery.

The receipts of the canneries represented by the models are summarised in Table 4. These are derived from Appendix 1, Table 1.5 in which physical quantities and unit values are given.

4.5 FINANCIAL ANALYSIS

It should be emphasised at the outset that although a simple method of financial analysis is demonstrated to show how the models might be used in, or adapted to, the conditions in different parts of the world, the report is not intended to provide a financial analysis of a particular enterprise operating such an installation. Such a financial analysis would require, apart from local factor costs, detailed knowledge of the capital structure of an enterprise (both equity and loan contributions), as well as knowledge of the taxation and depreciation provisions of the country in which it operated.

The discounted cash flow method is used to assess the financial performance of the cost models. This method enables a comparison of costs and receipts over a period of time to be made and summarised as the Net Present Value. This figure is the sum of the difference between inward (+) and outward (—) annual cash flows discounted at a particular rate over a period of time. Alternatively, the Internal Rate of Return can be calculated. This is the discount rate which equates inward and outward annual cash flows over a period of time, or, in other words, that gives a Net Present Value of zero. These measures are designed to assess the relative financial viability of the different canneries to the organisation(s) which might consider establishing them. In particular it provides an estimate of the return to capital investment after recovery of that investment. Hence it enables alternative schemes to be compared and placed in an order or rank from the point of view of financial performance.

The cost models are analysed over a life of 10 years. A residual (or terminal) value is allowed for those items of fixed capital cost with a life extending beyond year 10. This would be principally the cost of the building, which is assumed to have a life of 30 years, and the cost of the land. It is assumed that in the first year the plant operates at 50% of annual operating level.

A discount rate of 10% has been applied to derive the Net Present Value for each basic cost model and in addition the Internal Rate of Return in each case has been calculated. The rate of 10% corresponds to the test discount rate adopted by the UK Overseas Development Administration in project appraisal. It is illustrative and is not intended as a comment on what is appropriate in all circumstances. The selection

of the appropriate rate of return should be made through an assessment of local circumstances.

For variations to the basic cost models the Internal Rate of Return only has been calculated.

The discounted cash flow analysis of the three basic cost models operating under 'ideal' conditions of adequate raw material availability and potential to export all of the canned end product is given in Appendix 1, Tables 1.6 – 1.8. The results of these are summarised in Table 5 and discussed in 4.6.

Table 5

Results of the discounted cash flow analyses

	Model 1	Model 2	Model 3
Net Present Value (at 10% discount rate)	£830,328	£1,762,439	£758,803
Internal Rate of Return	61.5%	69.5%	59.0%

Source: Appendix 1, Tables 1.6 – 1.8.

4.6 RELATIVE PERFORMANCE OF THE COST MODELS

From Table 5 a comparison of the results between Models 1 and 2 indicates that economies of scale are available. Model 3, the more labour-intensive model, performs marginally less well than Model 1. In the country from which data were drawn the fish beheading and gutting and can-labelling operations are invariably carried out with machines. Given the relatively small proportion of annual operating costs attributable to labour, casual labour rates would have to be at a level about 75% of those used in this report for Model 3 to return a marginally better financial performance than Model 1.

Sensitivity analysis has been carried out to test independently the effect on the financial performance of the models of :

- (i) increased seasonality of fish supply reducing the number of shifts worked each year;
- (ii) 50% of the output being sold on the domestic market at a price of £0.11 per can and 50% sold on the export market at £0.18 per can instead of the export price of £0.18 per can assumed for all sales in the basic cost models; and
- (iii) an overall increase of 25% in annual operating costs.

The results of the sensitivity analyses are summarised in Table 6.

Table 6

The Internal Rates of Return resulting from the sensitivity analysis

	Model 1	Model 2	Model 3
Seasonality:			
200 shifts worked a year	47.5%	54.0%	45.0%
150 shifts worked a year	33.5%	38.5%	31.5%
50% of sales on domestic market	33.5%	39.0%	29.5%
25% increase in annual operating costs	36.7%	42.6%	32.0%
Basic cost models (from Table 5)	61.5%	69.5%	59.0%

In all cases, although much reduced, an apparently attractive rate of return is still found. Comparing Model 2 to Model 1 the benefits of economies of scale remain, though the reduction in throughput brought about by tighter seasonality of fish supply reduces its relative advantage over Model 2. Model 1 continues to give a marginally better financial performance than Model 3. However, the relative performance of Model 3 compared to Model 1 (or Model 2) worsens in a situation where the annual net operating cash flow is reduced, either through a decrease in annual sales revenue or through an increase in annual operating costs.

In many situations a canner is likely to experience a combination of the less favourable assumptions discussed in the above sensitivity analysis, in particular a contracted working season and the need to channel a significant proportion of his production onto the domestic market with lower end product prices pertaining. This has been the experience of many canners throughout the world and has lead to significant reductions in potential profitability as shown in the basic models above.

Many sardine canners operate over a season of 3 months or less and, even then, find raw material supplies difficult both with respect to quantity and quality. The sensitivity analysis was therefore extended to reflect these conditions and to investigate the combined effect of reducing shifts worked per annum to 150 and of reducing the end product value by channelling 50% of production onto the domestic market. The results are shown below:

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
Net Present Value at 10%	£56,395	£181,779	£12,422
Internal Rate of Return	14.0%	17.5%	11.0%

The result is to reduce significantly the Internal Rates of Return and illustrates the need to view the highly attractive rates of return shown for the basic models with great caution. In addition the sensitivity analysis above was further extended to incorporate the combined effect of a 25% increase in operating costs. The result was that for all models the Net Present Value at 10% was negative and the projects were not viable, all showing negative Internal Rates of Return.

Thus the imposition of operating constraints often incurred in practice clearly illustrates how the high rates of return of the basic models, operating under 'ideal' conditions, are rapidly eroded and how great care must be exercised in assessing raw material availability and market prospects before embarking on a canning venture.

4.7 CONCLUSIONS

This section has shown a simple method of appraising the financial performance of small fish canneries. Although the canning of sardines has been adopted in the design of the cost models the general principles of analysis are applicable to the canning of any species of fish. However, appropriate adjustments would be required in the items of equipment and the operations carried out.

It is evident that the profitability of a canning enterprise is highly sensitive to seasonality of fish supply. A short fishing season which restricts the number of days' operation could have a serious adverse effect on financial prospects. Hence this aspect needs to be assessed with care. The quality of products and the market to be served must also be adequately examined as annual revenue will vary particularly with the type of filler used and type of pack marketed. The price of raw material is important and for sardine or highly seasonal species, it may have to be high to encourage fishermen to invest in harvesting gear to ensure sufficient volumes of landed raw material.

The high cost of cans in developing countries relative to product value may well be a limiting factor in profitability in many situations. In assessing the prospects of establishing a fish cannery it is advisable therefore to take account of the prospects

for alternative forms of fish processing, such as freezing, where these are applicable to the particular species available.

The effect on profitability of substituting labour for machinery is obviously dependent on the cost of additional labour relative to the savings in capital outlay. With the relative costs given in this section the more labour-intensive model gave a marginally less favourable financial performance. However, it might be considered that the social gains from increased employment outweigh this marginal financial disadvantage and favour the adoption of the more labour-intensive techniques. This point could be illustrated more clearly by the techniques of economic analysis not considered in this report.

In conclusion, very many sardine canneries around the world have not proved to be profitable investments. This is mainly because of the short season over which the resource is available, resulting in high fixed costs per unit of raw material landed, and high processing costs. In many cases the short season has been such as to deter fishermen from investing in the required gear. In addition canners have often found it difficult to persuade local fishermen to land the fish in condition good enough for canning. Often volumes of end product have been low and consequently difficult to export. With these factors in mind, although the economics of canning may appear attractive, great care should be taken to assess all aspects which lead to project viability and to compare alternative methods of utilising the fish which may well prove more profitable.

Appendices

APPENDIX 1: ESTABLISHMENT AND OPERATING COSTS FOR MODELS 1, 2 AND 3

Table 1.1

Cost of raw materials and packing materials

Item	Model 1	Model 2	Model 3	Notes
Sardines (with scales)				
Quantity (tonnes)	500	1,000	500	
Value (£)	60,000	120,000	60,000	At £120 per tonne
Filler				
Quantity (tonnes)	87.5	175	87.5	Vegetable oil (e.g. sunflower seed oil), 35 g per can
Value (£)	35,000	70,000	35,000	At £400 per tonne
Salt				
Quantity (tonnes)	10	10 ²⁰	10	
Value (£)	200	400	200	At £20 per tonne
Cans				
Quantity (nos.)	2,525,000	5,050,000	2,525,000	10,000 cans per day, Models 1 and 3; 20,000 cans per day, Model 2. Plus 1% for damaged cans
Value (£)	106,050	212,100	106,050	At £0.042 per can
Cartons				
Quantity (nos.)	25,000	50,000	25,000	Carton holding 100 cans
Value (£)	8,250	16,500	8,250	£0.33 per carton

Table 1.2

Cost models – labour requirements

Item	Model 1	Model 2	Model 3	Notes
Managerial	1	1	1	At £1,750 per annum
Engineer/maintenance	1	1	1	At £1,400 per annum
Supervisory	1	2	1	At £850 per annum
Clerical	2	3	2	At £600 per annum
Semi-skilled/unskilled	56	112	94	Mainly seasonal at average of £0.20 per hour or £430 per annum
beheading and gutting	(6)	(12)	(36)	
rinsing and brining	(5)	(10)	(5)	
can filling	(20)	(40)	(18)	
cooking	(4)	(8)	(4)	
can seaming and washing	(4)	(8)	(4)	
retorting	(4)	(8)	(4)	
can labelling	(2)	(4)	(12)	
packing cans in cartons	(5)	(10)	(5)	
general – (reception, storage, despatch)	(6)	(12)	(6)	
of which permanent staff	10	20	18	

Table 1.3

Cost models – annual consumption of electricity, fuel oil and water

Item	Unit	Model 1	Model 2	Model 3	Notes
Electricity	kWh	18,500	24,000	13,750	At £0.045 per kWh
Fuel oil	litres	34,000	68,000	34,000	At £0.2 per litre
Water	'000 litres	8,750	17,500	8,750	At £0.066 per '000 litres

Table 1.4

Cost models – working capital

	(£ sterling)		
	Model 1	Model 2	Model 3
Three months' finished product (canned sardines)	135,000	270,000	135,000
One week's fish supply	1,400	2,800	1,400
Two months' operating expenses (other than fish)	41,380	80,540	44,280
Total	177,780	353,340	180,680

Table 1.5

Cost models — revenue from sales of cans of sardines and of fish waste

Item	Model 1	Model 2	Model 3	Notes
Cans of sardines				Models 1 and 3 at 10,000 cans per day; Model 2 at 20,000 cans per day
Quantity (nos.)	2,500,000	5,000,000	2,500,000	
Value (£)	450,000	900,000	450,000	At £0.18 per can
Fish waste				
Quantity (tonnes)	165	330	165	At 33% of fish input
Value (£)	2,475	4,950	2,475	At £15 per tonne
Total receipts (£)	452,475	904,905	452,475	

Table 1.6

Discounted cash flow, Model 1

Year	Fixed capital (£)	Working capital (£)	Operating costs (£)	Cash outflow (£)	Cash* inflow (£)	Net cash flow (£)	Discount factor (10%)	Discounted cash flow (£)
0	125,150	—	—	125,150	—	(125,150)	1.000	(125,150)
1	—	177,780	146,345	324,125	226,240	(97,885)	0.909	(88,977)
2	—	—	266,900	266,900	452,475	185,575	0.826	153,285
3	—	—	266,900	266,900	452,475	185,575	0.751	139,367
4	—	—	266,900	266,900	452,475	185,575	0.683	126,748
5	—	—	266,900	266,900	452,475	185,575	0.621	115,242
6	—	—	266,900	266,900	452,475	185,575	0.564	104,664
7	—	—	266,900	266,900	452,475	185,575	0.513	95,200
8	—	—	266,900	266,900	452,475	185,575	0.467	86,664
9	—	—	266,900	266,900	452,475	185,575	0.424	78,684
10	(11,000)	(177,780)	266,900	266,900	641,255	374,355	0.386	144,501

Net Present Value 830,328
Internal Rate of Return = 61.5%

Note: *Annual revenue except for Year 10 when the recovered value of fixed and working capital is also included.

Table 1.7

Discounted cash flow, Model 2

Year	Fixed capital (£)	Working capital (£)	Operating costs (£)	Cash outflow (£)	Cash* inflow (£)	Net cash flow (£)	Discount factor (10%)	Discounted cash flow (£)
0	215,290	—	—	215,290	—	(215,290)	1.000	(215,290)
1	—	353,340	282,680	636,020	452,475	(183,545)	0.909	(166,842)
2	—	—	522,750	522,750	904,950	382,200	0.826	315,697
3	—	—	522,750	522,750	904,950	382,200	0.751	287,032
4	—	—	522,750	522,750	904,950	382,200	0.683	261,043
5	—	—	522,750	522,750	904,950	382,200	0.621	237,346
6	—	—	522,750	522,750	904,950	382,200	0.564	215,561
7	—	—	522,750	522,750	904,950	382,200	0.513	196,069
8	—	—	522,750	522,750	904,950	382,200	0.467	178,487
9	—	—	522,750	522,750	904,950	382,200	0.424	162,053
10	(19,080)	(353,340)	522,750	522,750	1,277,370	754,620	0.386	291,283

Net Present Value 1,762,439
Internal Rate of Return = 69.5%

Note: *Annual revenue except for year 10 when the recovered value of fixed and working capital is also included.

Table 1.8

Discounted cash flow, Model 3

Year	Fixed capital (£)	Working capital (£)	Operating costs (£)	Cash outflow (£)	Cash* inflow (£)	Net cash flow (£)	Discount factor (10%)	Discounted cash flow (£)
0	111,450	—	—	111,450	—	(111,450)	1.000	(111,450)
1	—	180,680	154,930	335,610	226,240	(109,370)	0.909	(99,417)
2	—	—	281,380	281,380	452,475	171,095	0.826	141,324
3	—	—	281,380	281,380	452,475	171,095	0.751	128,492
4	—	—	281,380	281,380	452,475	171,095	0.683	116,858
5	—	—	281,380	281,380	452,475	171,095	0.621	106,250
6	—	—	281,380	281,380	452,475	171,095	0.564	96,498
7	—	—	281,380	281,380	452,475	171,095	0.513	87,772
8	—	—	281,380	281,380	452,475	171,095	0.467	79,901
9	—	—	281,380	281,380	452,475	171,095	0.424	72,544
10	(11,000)	(180,680)	281,380	281,380	644,155	362,775	0.386	140,031

Net Present Value 758,803
Internal Rate of Return = 59%

Note: * Annual revenue except for year 10 when the recovered value of fixed and working capital is also included.

APPENDIX 2: LIST OF ITEMS OF CAPITAL EQUIPMENT

	Model 1	Model 2	Model 3
Washing and brining tanks	2	4	2
Eviscerating tables (stainless steel)	—	—	2
Beheading and gutting machine	1	2	—
Filling tables (stainless steel)	1	2	1
Cooker and racks	1	2	1
Oil dispenser (60 cans per minute)	1	1	1
Seamer (20 cans per minute)	1	—	1
(40 cans per minute)	—	1	—
Automatic weigh machine (30 cans per minute)	1	—	1
(60 cans per minute)	—	1	—
Retorts	1	2	1
Can washer (60 cans per minute)	1	1	1
Can labelling machine	1	1	—
Boiler	1	1	1
Chlorinator unit	1	1	1
Effluent treatment equipment	1	1	1
Other items of equipment			
Conveyers			
Trolleys, trays etc.			
Fish weigh machines			
Oil storage tank			
Water storage tank			
Office equipment			
Water and electricity fittings			

